THE VALUE OF SOYBEAN AND ALFALFA HAY IN MILK PRODUCTION

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BULLETIN
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NUMBER 267 DECEMBER, 1913

THE VALUE OF SOYBEAN AND ALFALFA HAY IN MILK PRODUCTION

BY R. E. CALDWELL*

INTRODUCTION

The purchase of nitrogenous feeds for dairy cows has in recent years assumed enormous proportions. As a general rule, these feeds are concentrates, such as the by-products: bran, middlings, linseed oil meal, cotton-seed oil meal, gluten feed and distillers' grains. Several of these with other feeds and filling materials have been mixed to form the so-called "ready to use" rations that are being rather widely distributed. The prevailing high prices of feeds in general and the great demand for feeds suitable for dairy cows have caused prices for these feeds to become very high; so high, in fact, that some dairymen have come to feel that they can scarcely afford to purchase them. The question naturally arises, "Must these feeds be used in order to produce dairy products at a profit, or may home-grown feeds be used in their places?" It is obvious that no answer can be given that will apply to all conditions. However, in order to secure data which may assist feeders to determine which course is best suited to the conditions with which they are dealing, two experiments have been conducted at this Station to compare such rations. The first will be discussed in Part I, and the second in Part II of this bulletin.

PLAN

The first experiment was planned to compare soybean hay with bran and cotton-seed meal as a source of protein. This experiment consisted of two tests; one conducted in 1908 and the other in 1909.

*Resigned October 5, 1911.

PART I

In selecting animals for this test, the following points were considered: producing capacity, breed, age, period of lactation and duration of pregnancy. Eleven cows were used in the 1908 test and nine in the 1909 test.

Tables I and II give the exact data regarding the points considered in the selection of the cows for these tests. These tables show that the two lots were quite similar, and the comparisons obtained are believed to be fair.

TABLE I. Cows used in the 1908 test.

Name of cow	Breed	Age yrs.-mos.	Date of calving	Date bred	Production of milk per day
Lot 1					Lbs.
Miami Pride	Guernsey	10-8	Nov. 21, 1907	Feb. 8, 1908	25 65
Topsy May	Jersey	6-0	Oct. 13, 1907	Feb. 27, 1908	19.35
Mantee Mahomet	Holstein	4-9	Oct. 7, 1907	Mar. 9, 1908	20.56
Teeny Gray 2nd	Jersey	2-9	Sept. 15, 1907	Jan. 11, 1908	14.67
Little May	Jersey	6-4	Aug. 29, 1907	Oct. 13, 1907	17.48
Average		5-8			19.54
Lot 2					
May's 2nd	Jersey	11-11	Nov. 9, 1907		21.25
Phillip's 4th	G. Guernsey	9-11	Nov. 10, 1907	Mar. 29, 1908	21.51
Grace Daw	Holstein	6-10	Sept. 23, 1907	Feb. 15, 1908	24.82
Fair Mahomet	Holstein	2-8	Sept. 12, 1907	Jan. 16, 1908	21.18
May 2nd Pedro	Jersey	4-0	Aug. 17, 1907	Mar. 9, 1908	12.45
Bessie Nervillette	Jersey	4-7	Dec. 4, 1907	Feb. 4, 1908	21.39
Average		8-8			20.43

TABLE II. Cows used in the 1909 test.

Name of cow	Breed	Age yrs.-mos.	Date of calving	Date bred	Production of milk per day
Lot 1					Lbs.
Grace Daw	Holstein	7-10	Nov. 16, 1908	Mar. 18, 1909	35.08
B. Nervilette	Jersey	5-7	Nov. 18, 1908	Feb. 17, 1909	21.66
May 2nd Pedro	Jersey	5-5	Dec. 10, 1908	Mar. 26, 1909	24.85
Teeny Gray 2nd	Jersey	3-9	Oct. 18, 1908	Jan. 23, 1909	16.46
Average		5-8			24.52
Lot 2					
Lady Thorne's 4th	Holstein	3-9	July 30, 1908	Nov. 8, 1908	26.91
Fair Mahomet	Holstein	3-8	Oct. 16, 1908	Feb. 28, 1909	23.50
Miami Pride	Guernsey	11-8	Oct. 29, 1908	Mar. 26, 1909	29.14
Little May	Jersey	7-4	July 20, 1908	Dec. 8, 1908	16.16
Topsy May	Jersey	7-0	Dec. 8, 1908		26.58
Average		6-6			26.26

During the entire time that the cows were under observation the milk of each cow was weighed and sampled separately at each milking. A container was provided for the samples from the milk of each cow, and the composite samples thus obtained were tested weekly for butterfat. The feeds were analyzed under the direction of Mr. J. W. Ames, chief in Chemistry at the Station, with results as shown in the following tables:

TABLE III: Composition of feeds used in the 1908 test—Lbs. per 100.

Name of feed	Water	Ash	Protein	Fiber	Nitrogen-free extract	Ether extract
Silage	76.825	.958	1.891	5.467	13.505	1.360
Soybean hay	12.748	7.855	11.627	28 850	36.684	2.236
Corn stover	20.252	4.383	4.248	26.931	42.141	2.045
Soybean hay, refuse	14.324	5.135	6 942	40.413	32.006	1.189
Corn stover, refuse	26 592	3.642	2.760	31.562	33.816	1.628
Cotton-seed meal	10.196	7.195	40.260	8.000	25.093	9.256
Bran	12.920	5 692	15 320	8.747	53.996	3.325
Corn meal	16.120	1.402	9.390	2.077	67.074	3.947

TABLE IV. Composition of feeds used in the 1909 test.—Lbs. per 100.

Name of feed	Water	Ash	Protein	Fiber	Nitrogen-free extract	Ether extract
Silage	68.36	1.26	2 20	8.12	19.24	.82
Soybean hay	13.83	6.10	13.52	25.71	37.80	3.04
Corn stover	12.22	5.24	5.73	26.25	49.00	1.56
Soybean hay, refuse	16.76	4.69	10.51	32.25	33.56	2.23
Silage, refuse	66.08	1.50	2.06	11.04	18.74	.58
Corn Stover, refuse	24.16	3.73	3 74	27.24	39.89	1.24
Cotton-seed meal	3.30	6.73	40.47	6.97	31.80	10.73
Bran	13.35	4.99	13.88	7.06	56.98	3.74
Corn meal	17.93	1.25	7.51	1.87	68.15	3.29

There was a slight difference in the composition of the feeds used in the two experiments. The moisture in the silage used for the two tests varied somewhat over 8 percent; the cotton-seed meal was also found to contain much less moisture in the second test (1909) than in the first test (1908); otherwise, the composition of the various feeds for the two tests was quite similar.

In both tests the rations for the corresponding lots were the same, and were as follows: Lot 1 in both tests received corn silage, soybean hay, and a grain mixture made up of 6 parts, by weight, of corn meal and 1 part of cotton-seed meal. Lot 2 in both tests received corn silage, corn stover and a grain mixture made up of equal parts, by weight, of corn meal, wheat bran and cotton-seed meal.

It will be noticed that, in both cases, Lot 1 received a ration in which a very small amount of purchased feed was used; while a relatively large amount of both bran and cotton-seed meal were used in the ration supplied to Lot 2 in both tests. The plan of feeding

during the preliminary and subsequent periods was the same except in the period subsequent to the second test, in which case two cows of Lot 1 were continued on soybean hay and two cows of Lot 2 were continued on bran and cotton-seed meal; while the remainder of both lots received mixed hay and silage as a roughage and corn and cotton-seed meal as grain.

The following prices of feeds and product were used in all calculations:

Wheat bran	$24.00 per ton
Corn meal	20.00 " "
Cotton-seed meal	30.00 " "
Corn silage	3.00 " "
Corn stover	4.00 " "
Soybean hay	8.00 " "
Alfalfa hay	10.00 " "
Milk (whole)	1.00 per cwt.
Milk (skim)	.15 " "
Butterfat	.25 per lb.

RESULTS OF THE FIRST TEST

In order to obtain definite data as to the performance of the various individuals when fed similarly, all cows in this test were fed for the preliminary period of 31 days the same ration received by Lot 1 during the test. They were then divided into two lots as shown in Table I, and were fed the rations given above. The comparison proper continued for 60 days and subsequent records were kept for 30 days, making in all 121 days.

FEEDS CONSUMED

Table V shows the amount of feed consumed by each lot during the 60 days.

TABLE V. Feed consumed during 60 days test, 1908.

Lot 1. Ration during test: corn silage, soybean hay, corn and cotton-seed meal.								
Name of cow	Total lbs. feed consumed				Average daily lbs. feed consumed			
	Corn meal	Cotton-seed meal	Silage	Soybean hay	Corn meal	Cotton-seed meal	Silage	Soybean hay
Miami Pride	364.8	60.8	2,098	515	6.08	1.01	34.96	8.58
Topsy May	308.4	51.4	2,100	570	5.14	.86	35.00	9.51
Mantee Mahomet	358.8	59.8	2,029	448	5.98	.99	33.82	7.47
Teeney Gray 2nd	308.4	51.4	1,924	504	5.14	.86	32.08	8.41
Little May	308.4	51.4	1,891	525	5.14	.86	31.53	8.76
Average	329.7	54.9	2 008	512	5.49	.91	33.47	8.54

TABLE V. Concluded. Feed consumed during 60 days test, 1908.

Name of cow	Total lbs. feed consumed					Av. daily lbs. feed consumed				
	Bran	Corn meal	Cotton-seed meal	Silage	Corn stover	Bran	Corn meal	Cotton-seed meal	Silage	Corn stover
Lot 2. Ration during test: corn silage, corn stover, corn, bran and cotton-seed meal										
May's 2nd	172	172	172	2,098	464	2.86	2.86	2.86	34.96	7.74
Phillip's 4th	150	150	150	2,100	459	2.50	2.50	2.50	35.00	7.65
Grace Daw	172	172	172	2,100	508	2.86	2.86	2.86	35.00	8.46
Fair Mahomet	172	172	172	2,088	400	2.86	2.86	2.86	34.81	6.67
May 2nd Pedro	150	150	150	2,050	538	2.50	2.50	2.50	34.17	6.43
Bessie Nervilette	150	150	150	2,095	441	2.50	2.50	2.50	31.53	8.76
Average	161	161	161	2 088	468	2.68	2.68	2.68	34.24	7.61

This table shows that the silage consumed per day was slightly greater in Lot 2 though the difference amounted to little. Lot 1 consumed somewhat more of the soybean hay than did Lot 2 of the stover. Less of the soybean hay was refused than of the stover. Owing to the coarse nature of these feeds, a large percentage of each was refused. The total number of pounds of grain consumed daily was greater with Lot 2, and these grains were the most expensive. The total amount of nutrients consumed by the two lots was practically the same.

The average daily nutrients consumed is shown in Table VI; also the composition of an average daily ration. Lot 2 received slightly more protein and fat, yet it is interesting to note how closely the two rations agree in total composition.

TABLE VI: Average daily nutrients consumed, 1908.

Name of cow	Protein (lbs.)	Crude fiber (lbs.)	Nitrogen-free extract (lbs.)	Ether extract (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn meal, cotton-seed meal				
Miami Pride	2.884	3.988	12.448	1.057
Topsy May	2.798	4.332	12.082	1.017
Mantee Mahomet	2.749	3.523	11.848	1.018
Teeny Gray 2nd	2 667	3.729	11.336	.964
Little May	2.681	3.841	11.374	.961
Average	2.756	3.883	11.818	1.003
Lot 2. Ration during test: corn silage, corn stover, bran, corn, cotton-seed meal				
May's 2nd	2.943	4.255	12.683	1.133
Phillip's 4th	2.703	4.158	12.119	1.071
Grace Daw	2.964	4.485	12.931	1.145
Fair Mahomet	2.911	3.907	12.298	1.113
May 2nd Pedro	2.654	3.729	11.596	1.040
Bessie Nervilette	2.693	4.060	12.273	1.066
Average	2.811	4.099	12.272	1.095

While there was some difference in the average daily production, it continued through all three periods. This with the equal amount of nutrients consumed must not be taken as proof that the nutrients in a given amount of roughage are equal in food value to an equal amount in grain; for rations rather than feeds are dealt with in this instance, and different roughages were used in the two rations, a lower grade being used in the ration for Lot 2.

TABLE VII: Average daily production of each cow, 1908.

Name of cow	31 days before test		60 days of test		30 days after test	
	Milk (lbs.)	Fat (lbs)	Milk (lbs.)	Fat (lbs.)	Milk (lbs.)	Fat (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn, cotton-seed meal						
Miami Pride	25.65	1.082	23.66	1.064	22.93	1.072
Topsy May	19.35	1.130	17.55	1.062	17.10	1.043
Mantee Mahomet	20.56	.580	19.81	.590	19.60	.524
Teeny Gray 2nd	14.67	.889	14.31	.857	14.34	.853
Little May	17.48	.948	16.31	.992	15.71	.923
Average	19.54	.926	18.29	.897	17.93	.883
Lot 2. Ration during test: corn silage, corn stover, bran, corn, cotton-seed meal						
May's 2nd	21.25	1.158	18.80	1.067	18.00	1.013
Phillip's 4th	21.51	1.041	19.03	.935	17.25	.854
Grace Daw	24.82	.759	24.95	.783	26.68	.861
Fair Mahomet	21.18	.686	21 63	712	22 61	.695
May 2nd Pedro	12.45	.776	13.91	.874	14.01	.865
Bessie Nervilette	21.39	1.176	18.90	1.106	17.73	1.037
Average	20.43	.932	19.53	.913	19.38	.885
Difference	.89	.006	1.24	.016	1.35	.002

Table VII shows that Lot 2 gave slightly more milk and butterfat daily per cow than Lot 1, but this difference did not change with a change of ration. This shows that the two rations were practically equal in feeding value so far as milk and butterfat production is concerned. These results are shown more graphically in Figure 1. The scale to the left represents pounds of milk daily and that ot the right represents pounds of fat daily. The solid lines represent the production of Lot 1 and the broken lines that of Lot 2.

While the production of milk and fat is the important point to dairymen, the gain or loss in live weight should be taken into consideration. Table VIII shows that the gain in each lot was practically the same, being less than one-half pound per cow per day.

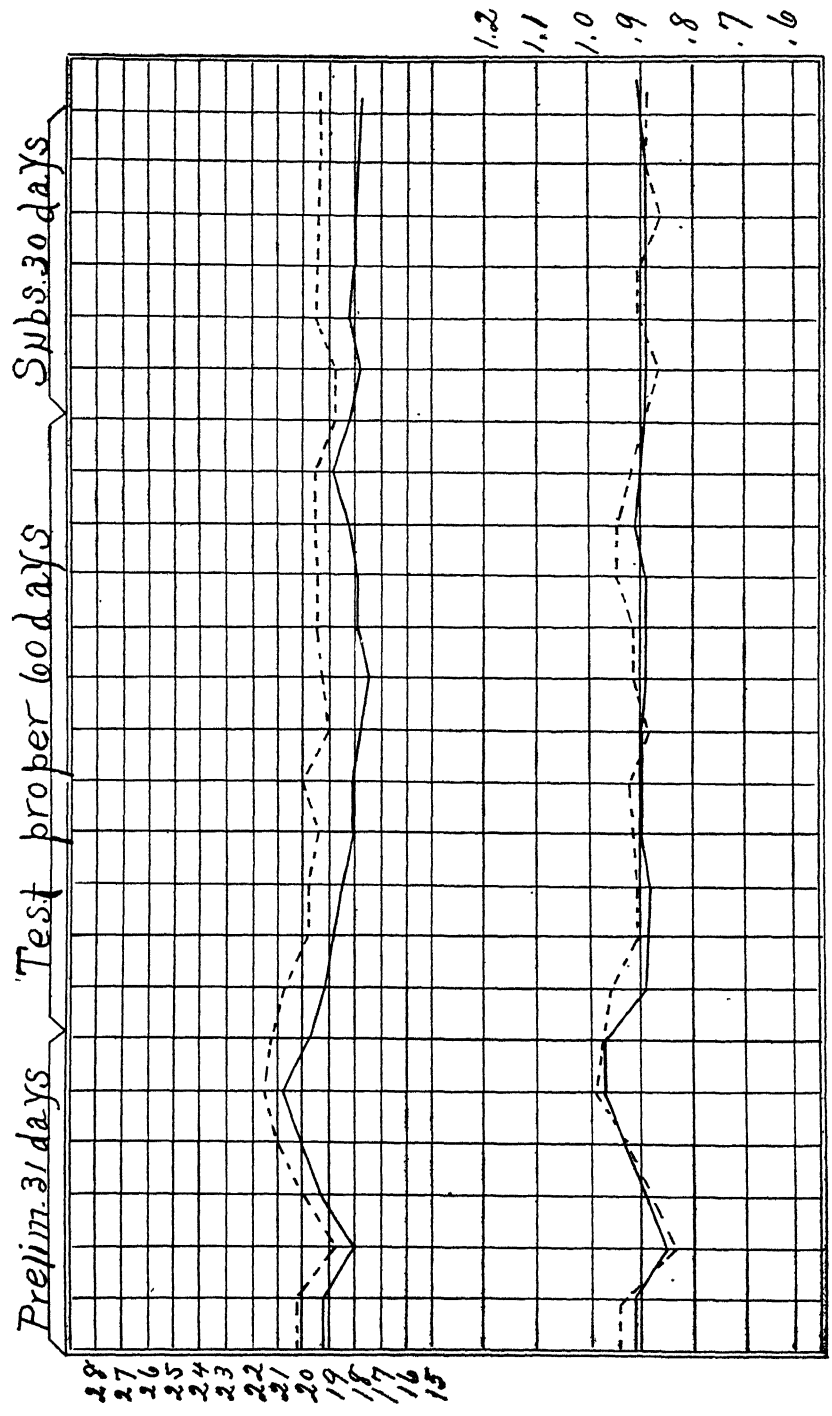
Prelim. 31 days
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Figure 1.

TABLE VIII: Summary of weights, 1908.

Name of cow	Average weight at beginning of test (lbs.)	Average weight at end of test (lbs.)	Gain or loss (—) for 60 days (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn and cotton-seed meal			
Miami Pride	925	948	23
Topsy May	829	858	29
Mantee Mahomet	1,103	1 144	41
Teeny Gray 2nd	753	767	14
Little May	825	862	37
Average	887	915.8	28.8
Lot 2. Ration during test: corn silage, corn stover, bran, corn and cotton-seed meal			
May's 2nd	929	956	27
Phillip's 4th	968	998	30
Grace Daw	1,152	1,133	—19
Fair Mahomet	853	898	45
May 2nd Pedro	834	877	43
Bessie Nervilette	824	850	26
Average	926.6	952	25.3

Another method of measuring the relative efficiency of the two rations is to compare the amount of dry matter consumed per unit of product, milk or butterfat. This comparison is shown in Table IX, and indicates that the difference is very small.

TABLE IX: Amount of dry matter required to produce a unit of product, 1908.

Name of cow	Milk produced (lbs.)	Butterfat produced (lbs.)	Total dry matter consumed (lbs.)	Dry matter per 100 lbs. of milk (lbs.)	Dry matter per pound butterfat (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn meal and cotton-seed meal					
Miami Pride	1,418.0	63.845	1,301.09	91.75	20.38
Topsy May	1,053.1	63.712	1,293.59	122 83	20.30
Mantee Mahomet	1,188.5	34.763	1,221.76	102.79	35.15
Teeny Gray 2nd	848.2	51.417	1,196.59	141.07	23.27
Little May	978.9	55.333	1,206.93	124.29	21.81
Average	1,097.3	53.814	1,243.99	113.36	23.23
Lot 2. Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal					
May's 2nd	1,128.4	64.040	1,328.53	117.73	20.75
Phillip's 4th	1,141.8	56.096	1,267 40	111.00	22 59
Grace Daw	1,497.0	46.995	1,360.74	90.89	28.96
Fair Mahomet	1,297.9	42.654	1,278.98	98.54	29.99
May 2nd Pedro	834.5	52.816	1,202.28	144.07	22.76
Bessie Nervilette	1 134.0	66.335	1,264.75	111.47	19.07
Average	1 172.3	54.823	1 283.78	109.51	23.42

FINANCIAL STATEMENT

The average dairyman is interested in the relative efficiency of the two rations, because of the effect on the cost per unit of product. A financial statement is given in Table X; but it must be kept in mind that this statement is correct only when the prices given on page 128 are used. Any change in prices would affect the financial results.

TABLE X: Cost of feeds and value of product, 1908.

Name of cow	Cost of product				Value of product			
	Total cost of feed	Average daily cost of feed	Cost per 100 lbs. milk produced	Cost per pound butterfat produced	Butter-fat	Skim-milk	Total	Average daily value of product
Lot 1. Ration during test: corn silage, soybean hay, corn and cotton-seed meal								
Miami Pride.....	$ 9.77	$ .163	$ .689	$ .153	$ 15.96	$2.03	$17.99	$ .300
Topsy May.....	9.28	.155	.881	.146	15.93	1.48	17.41	.290
Mantee Mahomet..	9.32	.165	.784	.268	8.69	1.73	10.42	.174
Teeny Gray 2nd...	8.76	.146	1.033	.170	12.85	1.20	14.05	.234
Little May.....	8.79	.147	.898	.159	13.83	1.38	15.21	.254
Average.....	9.18	.155	.857	.179	13.45	1.56	15.01	.250
Lot 2. Ration during test: corn silage, corn stover, corn meal, bran and cotton-seed meal								
May's 2nd.....	$10.44	$ .174	$ .925	$ .163	$ 16.01	$1.60	$17.61	$ .294
Phillip's 4th.....	9.62	.160	.843	.172	14.02	1.63	15.65	.261
Grace Daw.....	10.53	.176	.703	.224	11.75	2.18	13.93	.232
Fair Mahomet....	10.29	.172	.793	.241	10.66	1.88	12 54	.209
May 2nd Pedro....	8.71	.145	1.044	.165	13.20	1.17	14.37	.240
Bessie Nervilette..	9.57	.160	.844	.144	16.58	1.60	18.18	.303
Average.....	9.86	.164	.858	.185	13.70	1.68	15.38	.256

While profit is the practical test of the value of feeds, market conditions fluctuate to such an extent that no definite conclusions that will apply through a series of years can be drawn. This table shows that the cost of the product under the market prices which were applied was practically the same for both lots, although Lot 1 yielded the product at a slightly lower cost.

RESULTS OF THE SECOND TEST

Nine cows were used in this test, which was practically a repetition of the foregoing test. Lot 1 contained four cows, and Lot 2, five cows (See Table 2). The rations used were the same as those used in the previous test except that a change, as previously stated,

was made during the subsequent period, (See page 128). The test continued for 133 days—28 days preliminary, during which both lots were on the soybean ration, 77 days on the different rations, and 28 days subsequent to this period.

TABLE XI: Feed consumed during test, 1909.

Lot 1. Ration during test: corn silage, soybean hay. corn meal and cotton-seed meal

Name of cow	Total pounds feed consumed				Average daily pounds feed consumed			
	Corn meal	Cotton-seed meal	Silage	Soybean hay	Corn meal	Cotton-seed meal	Silage	Soybean hay
Grace Daw	475.2	79 2	3,431	870	6 17	1.03	31.57	11.30
Bessie Nervilette..	475.2	79.2	2,596	594	6.17	1.03	33 72	7.71
May 2nd Pedro....	475.2	79.2	1,980	628	6.17	1.03	25.71	8.16
Teeny Gray 2nd...	422.4	70.4	2,311	634	5.49	.91	30.02	8.24
Average.....	462.0	77.0	2,329	681.7	6.00	1.00	30.25	8.86

Lot 2. Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal

Name of cow	Total pounds feed consumed					Average daily pounds feed consumed				
	Bran	Corn meal	Cotton-seed meal	Silage	Stover	Bran	Corn meal	Cotton-seed meal	Silage	Corn stover
Lady Thorne 4th..	231.0	231.0	231.0	1,919	487.0	3.00	3.00	3.00	24.93	6.32
Fair Mahomet.....	231.0	231.0	231.0	2,399	440.0	3.00	3.00	3.00	31.15	5.72
Miami Pride.....	231.0	231.0	231.0	2,623	511.0	3.00	3.00	3.00	34.07	6.64
Little May	205.3	205.3	205.3	1,775	564.0	2.67	2.67	2.67	23.06	7.33
Topsy May.....	231.0	231.0	231.0	2,619	420.0	3.00	3.00	3.00	34.02	5.64
Average.....	225.8	225.8	225.8	2,267.6	482.7	2.93	2.93	2.93	31.44	6.33

Table XI shows the amount of food consumed by each lot during the different periods. The silage consumed by Lot 1 exceeded the silage consumed by Lot 2 by 1 percent; this is the reverse of what took place in the first test. In both the first and second test, 37 percent more soybean hay was consumed than stover. As in the first test, the total amount of grain consumed was greater for Lot 2 by 25.6 percent, and these grains were the most expensive. As in the previous test, the total nutrients consumed was practically the same.

Table XII shows the amount of nutrients consumed daily by each cow. On the average, there was very little difference between the nutrients consumed by the two lots.

TABLE XII: Average daily pounds nutrients consumed, 1909

Name of cow	Protein	Crude fiber	Nitrogen-free extract	Ether extract
Lot 1. Ration during test: corn silage, soybean hay, corn meal and cotton-seed meal				
Grace Daw	3.314	5.386	15.254	.973
Bessie Nervilette	2 876	4.430	14.337	.883
May 2nd Pedro	2.716	3.951	12.806	.882
Teeny Gray 2nd	2.720	4.233	13.133	.825
Average	2.906	4.500	13.882	.876
Lot 2. Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal				
Lady Thorne 4th	2.881	4.027	13.123	.860
Fair Mahomet	2.977	4.432	13.998	.896
Miami Pride	3 033	4 579	14.443	.916
Little May	2.685	4.108	12.705	.799
Topsy May	3.033	4.469	14.460	.917
Average	2.922	4.323	13.746	.878

Table XIII shows that there is slight difference in the average daily production of milk in favor of Lot 2; this continues until the subsequent period. There is a slight difference in the production of fat in favor of Lot 1; this difference remains practically constant throughout the entire period, showing that the two rations were almost equal in productive value, which agrees with the results in the first test.

TABLE XIII: Average daily production of each cow, 1909.

Name of cow	28 days before test		77 days of test		28 days after test	
	Milk (lbs.)	Fat (lbs.)	Milk (lbs.)	Fat (lbs.)	Milk (lbs.)	Fat (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn meal and cotton-seed meal						
Grace Daw	35.08	1.070	28.50	.952	28.26	.927
Bessie Nervilette	21.66	1.225	19.59	1.140	17.34	.972
May 2nd Pedro	24.85	1.270	21.58	1.149	19.97	1.004
Teeny Gray 2nd	16.46	.968	14.10	.843	12.97	.749
Average	24.51	1.133	20.94	1.021	19.63	.913
Lot 2. Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal						
Lady Thorne 4th	26.91	.800	22.21	.741	18.62	.642
Fair Mahomet	32.50	1.040	27.57	.914	26.40	.864
Miami Pride	29.14	1.275	22.89	1.043	18.59	.823
Little May	16.16	.885	13.80	.839	13.53	.788
Topsy May	26.58	1.422	21.36	1.265	18.92	1.078
Average	26.26	1.084	21.56	.960	19.21	.839
Difference	1.75	.049	.62	.061	.42	.074

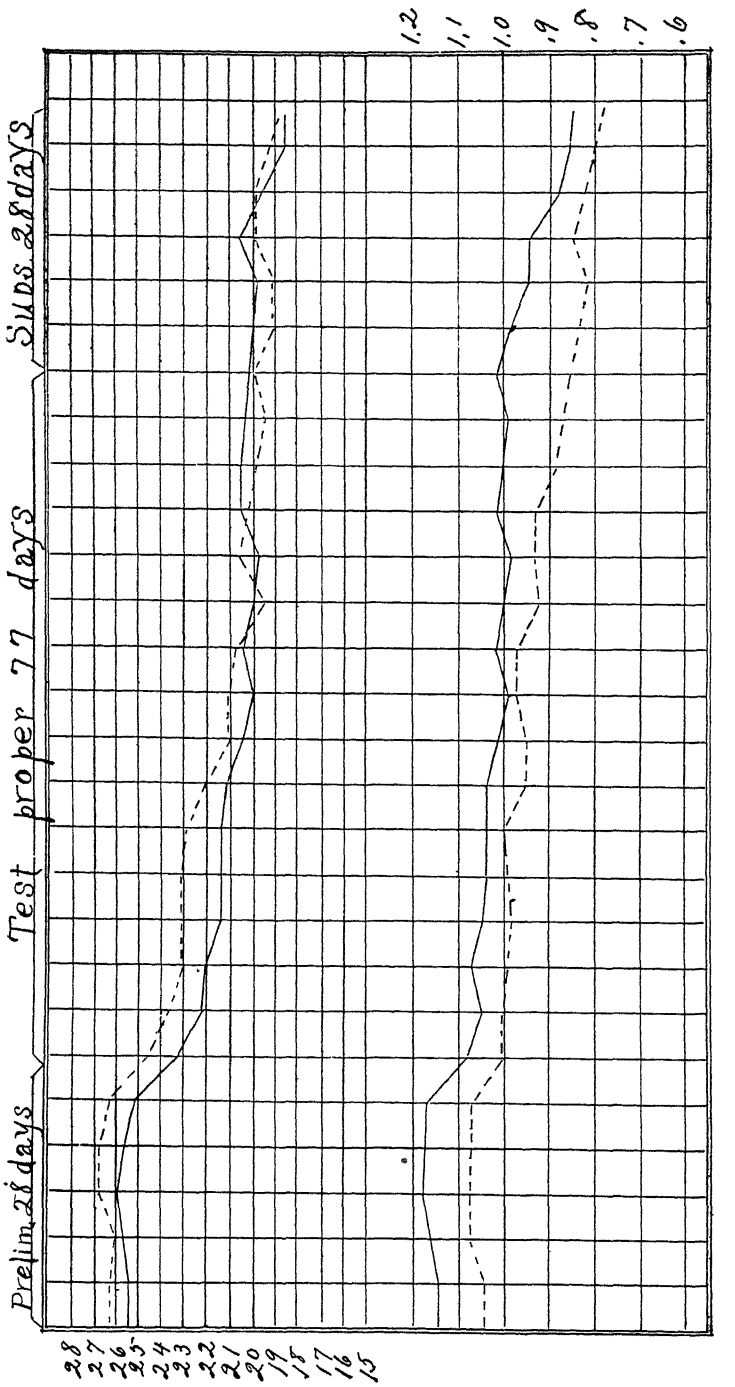
Prelim. 28 days
Test proper 77 days
Suds 28 days
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Figure 2.

Fig. 2 shows graphically the production of the two lots in the test of 1909. The scale to the left represents pounds of milk daily, and the scale to the right represents pounds of fat daily. The upper solid line represents the average daily production of milk by Lot 1 and the lower solid line represents fat produced daily. The upper broken line represents the average pounds of milk produced daily by Lot 2 and the lower broken line represents the average pounds of butterfat produced daily.

TABLE XIV: Summary of weights, 1909.

Name of cow	Average weight at beginning of test (lbs.)	Average weight, at end of test (lbs.)	Gain or loss (—) (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn meal and cotton-seed meal			
Grace Daw	1,139.0	1,155.0	16.0
Bessie Nervilette	845.0	862.0	17.0
May 2nd Pedro	842.0	833.0	—9.0
Teeny Gray 2nd	831.0	843.0	12.0
Average	914.2	923.2	9.0
Lot 2: Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal			
Lady Thorne 4th	988.0	1,011.0	23.0
Fair Mahomet	915.0	925.0	10.0
Miami Pride	1,015.0	1,015.0	0.0
Little May	821.0	863.0	42.0
Topsy May	877.0	906.0	29.0
Average	923.2	944.0	20.8

Table XIV shows the summary of the weights of the cows. The value of a ration can not be determined by considering the production of milk only, but the gain or loss in body weight should also be taken into account. The average gain for Lot 1 was 9 lbs. (1-6 pound daily) and that for Lot 2 was 20.8 lbs. (less than ⅓ lb. daily). In this test the grain ration produced the greater gain. Neither lot gained as much as in the first test, though the latter period extended for 17 days longer than the former.

Table XV shows the total amount of products yielded, the total amount of dry matter consumed, and the amount of dry matter required per unit of product. It appears that 5 percent more dry matter was required to produce a unit of product with the grain ration than with the soybean ration. This is a greater difference than in the previous test, but it is a small difference, and it means that the two rations were practically equally efficient.

TABLE XV: Amount of dry matter required to produce a unit of product, 1909.

Name of cow	Milk produced (lbs.)	Butterfat produced (lbs.)	Total dry matter consumed (lbs.)	Dry matter per 100 lbs. of milk (lbs.)	Dry matter per pound butterfat (lbs.)
Lot 1. Ration during test: corn silage, soybean hay, corn meal and cotton-seed meal					
Grace Daw	2,194.6	73.366	2,021.68	92.12	27.42
Bessie Nervilette	1,508.5	87.792	1,814 48	120.28	20.67
May 2nd Pedro	1,661.9	88.435	1,642.81	98 85	18.58
Teeny Gray 2nd	1 085.4	64.908	1,693.31	156.00	26.09
Average	1,612.6	78.618	1,793 07	111.19	22.81
Lot 2. Ration during test: corn silage, corn stover, bran, corn meal and cotton-seed meal					
Lady Thorne 4th	1,710.3	57.068	1,694.21	99.05	29.69
Fair Mahomet	2,122.6	70.409	1,806.71	85.11	25.66
Miami Pride	1.762.9	80 290	1,860.31	105.52	23.17
Little May	1,062.4	64.600	1,647.19	155 04	25.50
Topsy May	1,645.0	97.417	1,853.29	122.66	19.02
Average	1,660.6	73.957	1,772.34	106.72	23.96

FINANCIAL STATEMENT

Table XVI gives a financial statement of the results of the test. The difference in the daily cost of feed per cow was less than 1 cent in favor of the soybean ration. The difference in the cost of 100 pounds of milk was a little over 1 cent. The difference in the cost of butterfat was 2.9 cents per pound in favor of the soybean ration.

TABLE XVI. Cost of feeds and value of product, 1909

Name of cow	Cost of product				Value of product			
	Total cost of feed	Average daily cost of feed	Cost per 100 lbs. milk produced	Cost per lb. butterfat produced	Butterfat	Skimmilk	Total	Average daily value of product
Lot 1. Ration during test: corn silage, soybean hay, corn meal, cotton-seed meal								
Grace Daw	$13.07	$ .170	$ .595	$ .178	$18.33	$3.18	$21.51	$ .279
Bessie Nervilette	12.22	.159	.810	.139	21.95	2.13	24.08	.313
May 2nd Pedro	11.42	.148	.687	.129	22 11	2.36	24.47	.318
Teeny Gray 2nd	11.29	.147	1.040	.174	16.23	1.53	17.76	.231
Average	12.00	.156	.783	.155	19.65	2.30	21.95	.285
Lot 2. Ration during test: corn silage, corn stover, bran, corn meal, cotton-seed meal								
Lady Thorne 4th	$ 12.40	$ .161	$ .725	$ .217	$14.27	$2.48	$16.75	$ .218
Fair Mahomet	13.03	.169	.614	.185	17.60	3.08	20.68	.269
Miami Pride	13.50	.175	.766	.168	20 07	2.52	22.59	.293
Little May	11.38	.148	1.071	.183	15.59	1.50	17.09	.222
Topsy May	13.32	.173	.810	.168	24.35	2.32	26.67	.346
Average	12.72	.165	.797	.184	18.37	2.38	20.75	.269

A careful study of these two tests shows that they agree very closely in the results obtained, showing that a large share of the protein can be supplied in soybean hay instead of concentrates, with equal efficiency.

PART II.

PLAN

In view of the results secured through the use of soybean hay as a protein carrier, it was decided to conduct a similar experiment using alfalfa hay as the source of home-grown protein. Alfalfa is destined to become a very important crop in certain sections of Ohio, notably, the western sections. Its production will be attended with greater difficulty in the eastern section, because of the greater lack of lime in the soil. Its enormous yields and high protein content make it especially desirable for dairy purposes. It is possible to combine alfalfa with home-grown feeds in such manner as to secure a balanced ration for reasonably high milk production. If it is possible to get as good results from such rations as from rations containing high priced grain by-products, the cost of milk production will be reduced.*

Each lot consisted of 3 Jerseys and 3 Holsteins. Their ages varied from 2 years, 3 months to 8 years. On the whole the two lots appeared to be exceptionally well balanced; and it is believed that the results should be comparable from this standpoint.

TABLE XVII. Division of cows.

Name of cow	Breed	Age at beginning of test (yrs.)—(mo.)	Date of last calf	Date bred
Lot 1				
Lady May Pedro	Jersey	2—6	Nov. 5, 1909	Apr. 3, 1910
Little May	"	8—5	Sept. 26, 1909	Jan. 13, 1910
Fair Mahomet	Holstein	4—9	Nov. 28, 1909	Apr. 14, 1910
Mantee 3rd	"	2—4	Nov 2, 1909	Mar. 29, 1910
Lady Gretta	"	2—6	Dec. 20, 1909	Mar. 24, 1810
Bessie Lambert	Jersey	2—3	Jan. 17, 1910	Apr. 29, 1910
Average	.....	3—10	Nov. 21, 1900	Mar 24, 1910
Lot 2				
Bessie Nervilette	Jersey	6—9	Dec. 3, 1909	Apr. 15, 1910
Grace Daw 4th	Holstein	2—5	Nov. 13, 1909	Apr. 5, 1910
Teeny Gray 2nd	Jersey	4—11	Oct. 29, 1909	May 25, 1910
Lady Thorne 4th	Holstein	4—11	Aug. 11, 1909	Nov 11, 1909
Fair Mahomet 1st	"	2—6	Dec. 26, 1909	May 5, 1910
Lucy May	Jersey	2—4	Jan. 8, 1910	Apr. 17, 1910
Average	.....	4—0	Nov. 15, 1909	Mar. 29, 1910

*For information about soybean culture and yields see Circulars 78, 132 and Bul. 237 of the O. A. E. S

The ration supplied Lot 1 consisted of corn meal, corn silage, and alfalfa hay; and that supplied Lot 2 consisted of corn meal, wheat bran, cotton-seed meal, corn silage and corn stover, the nutritive ratio being practically the same. The test proper lasted for 56 days during which time the two lots were on the rations mentioned above. In order to determine their production when on like rations, both lots were fed for a preliminary period of four weeks on the ration prescribed for Lot 1. For four weeks subsequent to the test proper, both lots were fed the ration prescribed for Lot 2.

FEED CONSUMED

TABLE XVIII. Average feed consumed daily during 56 days test

Name of cow	Corn meal (Lbs.)			Corn silage (Lbs.)	Alfalfa hay (Lbs.)
Lot 1					
Lady May Pedro	5.045			27.067	9.978
Little May	6.973			27.785	11.210
Fair Mahomet	6.045			30.058	13 330
Mantee 3rd	6.045			30.152	13.446
Lady Gretta	6.000			27.031	12.170
Bessie Lambert	5.000			25.000	9.473
Average	5.851			27.848	11.601
Lot 2	**Bran**	**Corn meal**	**Cotton-seed meal**	**Corn silage**	**Corn stover**
Bessie Nervilette	3 563	3 563	3 563	30.625	6.723
Grace Daw 4th	3.000	3.000	3.000	30.357	6.652
Teeny Gray 2nd	3.558	3.558	3 558	30.571	7.138
Lady Thorne 4th	3.000	3.000	3.000	29.393	6.339
Fair Mahomet 1st	3.000	3.000	3.000	30 000	4.183
Lucy May	2.500	2.500	2.500	25.000	2.647
Average	3.105	3.105	3.105	29.324	5.614

Table XVIII shows the average daily feed consumed during the test proper. It will be noted that the average daily grain ration received by Lot 1 was 5.85 pounds and that by Lot 2, 9.31 pounds. This shows over one-third more grain for Lot 2, while Lot 1 consumed twice as much alfalfa hay as Lot 2 consumed stover. There was not a great difference in the total amount of nutrients consumed. The exact figures are shown in the following table.

TABLE XIX. Compositions of average daily rations.

Lbs.	Feed	Dry matter (lbs.)	Protein (lbs.)	Crude fiber (lbs.)	Nitrogen free extract (lbs.)	Ether extract (lbs.)
Lot 1. Ration during test: Corn meal, corn silage, alfalfa hay.						
5 9	Corn meal	4.81	.52	.10	3.88	.22
27 8	Corn silage	5.67	.39	1.70	3.11	.13
11.6	Alfalfa hay	10.19	1.60	4.00	3.57	.14
	Total	20.67	2.51	5.80	10 56	.49
Lot 2. Ration during test: Bran, corn meal, cotton-seed meal, corn silage, stover						
3.1	Wheat bran	2.72	.48	.14	1.87	.12
3.1	Corn meal	2.53	.27	.05	2.04	12
3.1	Cotton-seed meal	2.80	1.25	.28	.85	21
29.3	Corn silage	5.97	.41	1.79	3.27	14
5.6	Corn stover	4.27	30	1.57	2.08	.07
	Total	18.29	2.71	3 83	10.11	.66

Lot 1 consumed less protein and more crude fiber than Lot 2; and from this one would naturally conclude that Lot 1 should produce a little less milk, unless the protein supply in ration 1 was entirely sufficient for their needs, in which case a slight excess was used in ration 2.

PRODUCT RETURNED

TABLE XX. Average daily production of milk and butterfat.

Name of cow	28 days before test		56 days of test		28 days after test	
	Milk (lbs.)	Fat (lbs.)	Milk (lbs.)	Fat (lbs.)	Milk (lbs.)	Fat (lbs.)
Lot 1. Ration during test: Corn meal, corn silage, alfalfa hay						
Lady May Pedro	12.9	.74	11.20	.65	10.8	64
Little May	21.4	1.22	18.20	1.03	16.5	.93
Fair Mahomet	31.8	1.08	32 15	1.03	33.6	1 02
Mantee 3rd	26.7	.87	25 22	.81	22 9	.74
Lady Gretta	30.4	1.02	30.64	.95	29.0	.84
Bessie Lambert	16.8	.84	14.87	.78	13.3	.77
Average	23.4	.96	22.04	.87	21 0	.82
Lot 2. Ration during test: Corn, bran, cotton-seed meal, corn silage, stover						
Bessie Nervilette	24.3	1.36	20 48	1 17	18.2	1.02
Grace Daw 4th	25.1	.88	23.68	.82	23 3	.71
Teeny Gray 2nd	20.1	1.21	19.12	1.20	16.7	1.03
Lady Thorne 4th	25.0	.74	24.37	.74	27.3	.81
Fair Mahomet 1st	23.1	.77	21.82	.68	18.1	.55
Lucy May	15.4	.90	13.77	.82	11.8	.71
Average	22.1	.98	20.54	.90	19.2	.80

Table XX shows the amount of milk and fat produced daily by the individual cows and the average. From this table we observe that Lot 1 produced slightly more milk than Lot 2, while Lot 2 produced slightly more butterfat than Lot 1. This difference in fat is undoubtedly due to the difference in the original percentage of butterfat between the two lots. While there is a difference between the two lots, this difference remains quite constant throughout the three periods, indicating that the two rations were practically equal in efficiency. Though there was little difference in the production of milk and butterfat, there seems to have been more difference in the weight of the animals. It is interesting to note that the lot producing the largest amount of butterfat gained the least in weight.

TABLE XXI. Summary of weights.

Name of cow	Average weight at beginning of test (lbs.)	Average weight at end of test (lbs.)	Loss or gain in weight during test (lbs.)
Lot. 1. Ration during test: Corn meal, corn silage and alfalfa hay.			
Lady May Pedro	791.0	855.0	64.0
Little May	811.0	842.0	31.0
Fair Mahomet	780.0	984.0	4.0
Mantee 3rd	872.0	934 0	62.0
Lady Gretta	938.0	960.0	22.0
Bessie Lambert	675.0	711.0	36.0
Average	844.5	881.0	36.5
Lot 2. Ration during test: Bran, corn, cotton-seed meal, corn silage and stover.			
Bessie Nervilette	884.0	882.0	—2.0
Grace Daw 4th	954.0	968.0	14.0
Teeny Gray 2nd	837.0	840.0	3.0
Lady Thorne 4th	978.0	991.0	13.0
Fair Mahomet 1st	1,008.0	1,003.0	—5.0
Lucy May	757.0	740.0	—17.0
Average	903.0	904.0	1.0

The table shows that Lot 1 gained an average of 36.5 pounds in the 56 days, while Lot 2 gained 1 pound. Every cow gained on the alfalfa ration while 3 gained and 3 lost on the other ration. (Average of 3 days weights.) This would indicate that a little more carbohydrates and fat were given than were required for milk production. This partly explains the difference in the amount of dry matter required to produce a given amount of milk and fat, as shown in the next table. It is also partly explained by the fact that Lot 1 received more crude fiber than did Lot 2.

TABLE XXII. Comparative production based on dry matter

Name of cow	Milk produced (lbs.)	Butterfat produced (lbs.)	Total dry matter consumed (lbs.)	Dry matter per 100 lbs. milk (lbs.)	Dry matter per lb butterfat (lbs.)	Average daily dry matter consumed (lbs.)
Lot 1. Ration during test: Corn meal, corn silage, alfalfa hay.						
Lady May Pedro	628.1	36.4	1,030.3	164.3	28.3	18.4
Little May	1,019.2	57.8	1,187.2	116.5	20.5	21 2
Fair Mahomet	1,800.6	57.7	1,275.1	70.8	22.1	22.8
Mantee 3rd	1,412.4	45.4	1,281.8	90.8	28.3	22.9
Lady Gretta	1,715.8	53.1	1,181.4	68.9	22.2	21.1
Bessie Lambert	812.8	43.6	979.8	120.6	22.5	17.5
Average	1,231.3	49.0	1,155.9	105.3	24.0	20.6
Lot 2. Ration during test: Bran, corn, cotton-seed meal, corn silage, corn stover.						
Bessie Nervilette	1,147.3	66.0	1,155.3	100.7	17.5	20.6
Grace Daw 4th	1,326.6	46.1	1,030.3	77.6	22.4	18.4
Teeny Gray 2nd	1,071.1	67.4	1,172.0	109.4	17.4	20.9
Lady Thorne 4th	1,365.2	41.6	1,043.2	76.4	25.0	18.6
Fair Mahomet 1st	1,222.0	38.1	957.9	78.4	25 2	17.1
Lucy May	771.6	46.0	762.4	98.8	16.6	13.6
Average	1,150.6	50.9	1,020.2	90.2	20.7	18.2

The above table shows that Lot 1 consumed 16.6 percent more dry matter per 100 pounds of milk, and 19.3 percent more per pound butterfat. The economy of a ration depends on its cost as well as on its efficiency. In the following table the costs are set forth; but, these costs apply only when the prices given on page 128 are used.

TABLE XXIII. Cost of product

Name of cow	Total cost of feed	Average daily cost of feed	Cost to produce 100 lbs. of milk	Cost to produce 1 lb. of butterfat
Lot 1. Ration during test: Corn meal, corn silage, alfalfa hay.				
Lady May Pedro	$ 7.90	$ .14	$1.26	$ .22
Little May	9.38	.17	.92	.16
Fair Mahomet	9.64	.17	.54	.17
Mantee 3rd	9.68	.17	.69	.21
Lady Gretta	9.04	.16	.53	.17
Bessie Lambert	7.55	.13	.93	.17
Average	8.86	.16	.81	.18
Lot 2. Ration during test: Bran, corn meal, cotton-seed meal, corn silage, stover.				
Bessie Nervilette	$10.71	$ .19	$ .93	$ .16
Grace Daw 4th	9.51	.17	.72	.21
Teeny Gray 2nd	10.74	.19	1.00	.16
Lady Thorne 4th	9.40	.17	.69	.23
Fair Mahomet 1st	9 20	.16	.75	.24
Lucy May	7.57	.14	.98	.16
Average	9.53	.17	.85	.19

It will be noted that the average difference in cost per 100 pounds of milk was 4 cents, and per pound butterfat was 1 cent in favor of Lot 1 on the alfalfa ration. It is interesting to note from the following table that the cost of the feed equaled 61 percent of the value of the product in Lot 1 and 68 percent in Lot 2, leaving 39 and 32 percent to be accounted for by labor, taxes, depreciation, interest, profit, insurance, etc.

TABLE XXIV. Value of product on butter basis,

Name of cow	Value of butterfat	Value of Skim milk	Total value of product	Average daily value of product
Lot 1. Ration during test: Corn meal, corn silage, alfalfa hay				
Lady May Pedro	$ 9.10	$ .89	$ 9.99	$ .18
Little May	14.45	1.44	15.89	.28
Fair Mahomet	14.43	2.61	17 04	.30
Mantee 3rd	11.34	2.05	13.39	.24
Lady Gretta	13 28	2.49	15.77	.28
Bessie Lambert	10 90	1.15	12.05	.22
Average	12.25	1.77	14.02	.25
Lot 2. Ration during test: Corn, bran, cotton-seed meal, corn silage, stover.				
Bessie Nervilette	$16.50	$1.62	$18.12	$.32
Grace Daw 4th	11.52	1.92	13.44	.24
Teeny Gray 2nd	16.85	1 51	18.36	.33
Lady Thorne 4th	10 40	1.99	12.39	.22
Fair Mahomet 1st	9.51	1.78	11.29	.20
Lucy May	11.49	1.09	12.58	.22
Average	12.71	1.65	14.36	.26

CONCLUSIONS

The above considerations show that alfalfa as well as soybeans can replace much of the high priced protein concentrates. Other legumes will answer the same purpose in a lesser degree. Clover is especially valuable in this respect, though not as good results should be expected per ton as with the soybean or alfalfa hay.

From the above it is evident that the extensive use of milling by-products or other commercial feeds is not necessary in milk production where legumes can be grown well. However, it often proves profitable to use such feeds and unless the use of home-grown feeds will yield as great a profit, all things considered, the commercial feeds should be used.

There are other factors than simply the efficiency of the ration which should be taken into consideration in figuring profits. Some of the factors are: Adaptability of the farm for growing the feeds desired; distance crops or feeds must be hauled to or from the market; the suitability of legumes for desired rotations; relative

value of fertilizing constituents of feeds purchased or produced; effect of legumes on the soil; the investment required in the purchase of grains or mill feeds; other and possibly more economical means of handling the soybean plant, and the consideration of market conditions.

The investment required when one depends on grains and mill feeds for protein is, perhaps, of minor importance. It is true, however, that on many occasions money with which to purchase feeds is not available, and also that the use of money during the time the feed is being consumed is of sufficient importance to warrant consideration.

The most economical way to handle the soybean plant is to many an unsettled question. On account of its nature of growth, the stem of the plant is quite woody and the cattle do not eat the stems readily. The time and manner of harvesting will control this point to a considerable extent. The practice of putting soybeans into the silo with corn silage is growing in some places, though it makes a strongly flavored silage. This plan is, perhaps, most popular at present; and on account of the difficulty in curing it for hay seems to be the best method of handling the soybean plant. However, the use of the soybean in the form of hay is altogether practical and is preferred by some.

An intimate knowledge of all local conditions, which is possible only to the man on the ground, is necessary if the most economical selections of feeds are to be made.

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CORRECTIONS TO CIRCULAR 136

On page 124 of Circular 136, directions are given for mixing fly repellants. It seems that two errors have been made. In formula 1, not over one-half pint of the acid should be used. This formula is hardly advisable since there is such great variation in the purity of carbolic acid designated as "crude."

In formula 2, the word *parts* should read *pints*. For formula 1, substitute 100 parts fish oil, 50 parts oil of tar (not tar) and 1 part of crude carbolic acid.